沖縄島における外来種セイロンベンケイの分布と立地環境

著者	Ogawa Shigeyuki
著者別表示	小川 滋之
journal or publication title	The journal of phytogeography and taxonomy
volume	62
number	1
page range	11-14
year	2014-11-01
URL	http://doi.org/10.24517/00053567

Journal of Phytogeography and Taxonomy **62** : 11-14, 2014

Shigeyuki Ogawa : **Distribution and environmental conditions of *Kalanchoe pinnata* as an invasive alien species on the Okinawa Island, southern Japan**

Graduate school of Horticulture, Chiba University, 648 Matsudo-shi Chiba 271-8510 Japan

Kalanchoe pinnata (Lam.) Pers. (Crassulaceae) is a succulent perennial herb distributed in the tropical and subtropical regions worldwide. In Japan, *K. pinnata* is distributed throughout the Nansei and Bonin Islands (Tsukamoto 1994). Because it is widely accepted that *K. pinnata* is native to Madagascar Island, it was most likely introduced into these regions for medical or horticultural purposes (Iha 2007). The exact date of introduction of the plant in the Okinawa Island of the Nansei Islands has not been determined. However, it was probably introduced during ancient times because the dialect name "boronboron", a name after its flowering form, has become a household word in the area.

Some studies have shown the rough distribution of *K. pinnata* on the Okinawa Islands (Nakata 1995; Shinzato and Takahara 2002; Iha 2007), but its exact habitat distribution has not been reported. In this study, the habitat distribution of *K. pinnata* is reported in the Motobu Peninsula of the Okinawa Island (Fig. 1) where it grows on various surface rocks or sediments. The light and soil conditions were also examined for these habitats.

1. Habitat distribution of *K. pinnata* in the Motobu Peninsula

Various surface rocks or soils are exposed in the Motobu Peninsula, and the land is used in diverse ways. The surface geology in this area is largely classified into Paleo-Mesozoic rocks

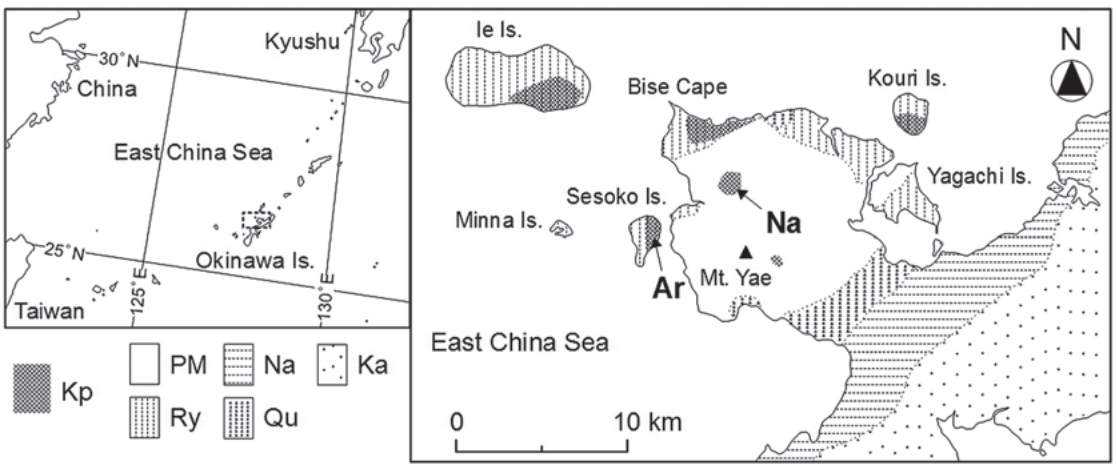

Fig. 1. Fig. 1. Location of the Motobu Peninsula, and relationship between the habitat distribution of *Kalanchoe pinnata* and geological distribution
Kp, habitat distribution of *Kalanchoe pinnata*; PM, Paleo-Mesozoic rocks; Na, Nago Mesozoic rocks; Ka, Kayo Paleogene rocks; Ry, Ryukyu Limestone (Quaternary); Qu, Quaternary unconsolidated clastics. Field surveys of day length and soil depth were conducted in a naturally bare area (Na, Yamazato district) and an artificially deformed area (Ar, Sesoko district). This map was based on the geological map provided in Hayashi (1985).

and Quaternary sediments (Hayashi 1985). The Paleo-Mesozoic rocks are mainly distributed in mountainous regions and composed of limestone, greenstones, mudstones, and cherts. Karst hills have developed on the Mesozoic limestones (Mokusaki 1988). The Quaternary sediments include unconsolidated clastics and the Ryukyu Limestone and constitute plains such as marine terraces and alluvial fans.

Vegetation in the Motobu Peninsula is largely affected by human land use (Environmental Agency 1981). Primary forests in the mountainous region are mainly composed of *Castanopsis sieboldii* (Makino) Hatus. ex T.Yamaz. et Mashiba, whereas the secondary of *Pinus luchuensis* Mayr. The plains are artificially modified for cultivation or residential areas where small secondary *P. luchuensis* forests are occasionally found.

The habitat of *K. pinnata* is distributed around Mt. Motobufuji and Mt. Katsuu where Mesozoic limestones are exposed. In addition, there are many *K. pinnata* habitats on the Sesoko and Ie Islands, which are composed of the Quaternary Ryukyu Limestone (Fig. 1). In the former Mesozoic limestones areas, *K. pinnata* was found on karst hills with natural openings as well as in artificially modified areas such as asphalt pavements and roadside slopes. These habitats are surrounded by several native species such as *Nephrolepis cordifolia* (L.) C.Presl, *Hernandia nymphaeifolia* (C.Presl) Kubitzki, and *Toddalia asiatica* (L.) Lam. (Fig. 2A). In the latter Quaternary Ryukyu Limestone areas, its habitats are structured as large patches where other invasive alien species coexist with *K. pinnata*, such as *Leucaena leucocephala* (Lam.) De Wit and *Bidens pilosa* L. var. minor (Fig. 2B).

Iha (2007) suggested a possible correlation between *K. pinnata* habitat and the distribution of carbonate rocks on the Nansei Islands because the habitats are found only in the Mesozoic or Quaternary limestone areas. Iha (2007) also inferred that this correlation could be explained by the geophysical and/or geochemical conditions specific to carbonate rocks. However, on the Bonin Islands, *K. pinnata* is mainly distributed in areas composed of basaltic rocks (Ono and Kobayashi 1985), which are not exposed in the Motobu Peninsula. Therefore, geophysical and/or geochemical conditions do not fully explain the habitat distribution in the studied area.

Nakata (1995) proposed another explanation for the habitat distribution in terms of human land use. The Mesozoic limestone in the mountainous regions was widely forested with small openings, whereas croplands or residential areas found on the Quaternary Ryukyu Limestone (Environment Agency 1981) will provide artificial “rocky” openings with asphalt or concrete substrates. Because *K. pinnata* is usually found on these artificial substrates rather than on natural rock in the range of the Quaternary limestone, land use, rather than surface geology, appears to be related to its habitat distribution.

2. Day length and soil depth in *K. pinnata*

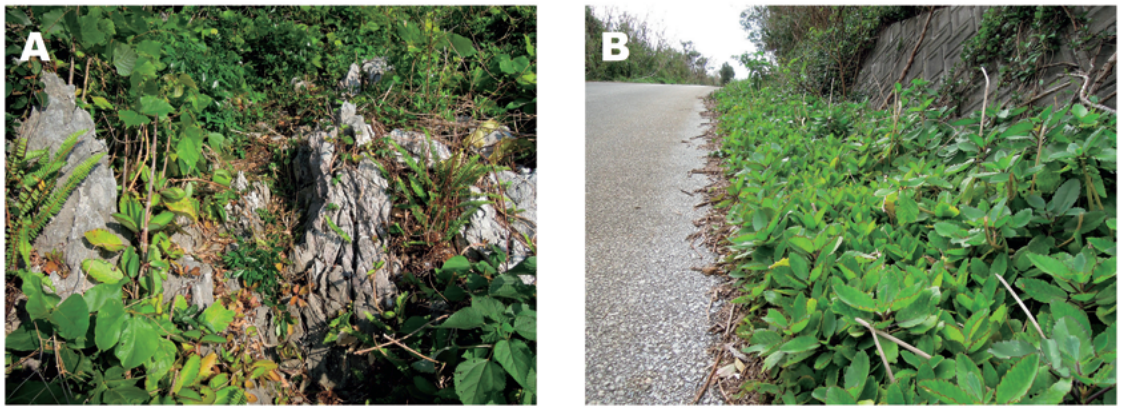

Fig. 2. View of *Kalanchoe pinnata* habitats in the naturally bare and artificially deformed areas

habitats

To estimate the effect of human activities on *K. pinnata* habitats, day length (Fig. 3) and soil depth (Fig. 4) were compared between naturally bare and artificially modified areas. In the day length survey, the sky rate of a habitat was measured on the basis of the images taken with a camera (VQ5010, Vistaquest, CA, USA) with a fisheye lens (Digital King Fisheye K-180, Toda Seiko, Saitama, JAPAN). Day length was estimated from the sky rate following the methods of the hemispherical image analysis program, CanopOn Version 2.03 (Takenaka 2009). Soil sampling was conducted with a penetrator (1 m length; 15 mm sampling caliber bullet) to examine soil depth.

The maximum possible duration of sunshine (Max. PDS) in the naturally bare habitats ranged from 40.0% to 90.0% of day light hours with a mean of 69.3% (Fig. 3). Max. PDS in the artificially modified habitats was 80.0% of day light hours with a mean of 78.3% (Fig. 3). In total of both habitats, 65.0% of the habitats recorded PDS of >70.0% (437 min/day). Therefore, the habitats in the artificially modified areas received more sunlight than those in the naturally bare areas.

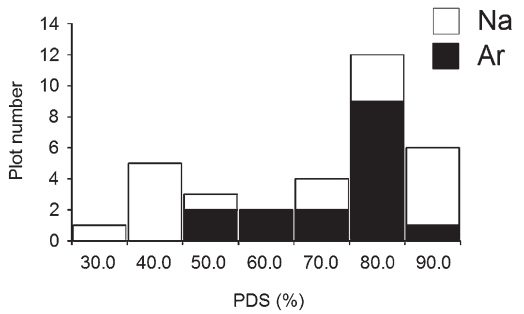

Fig. 3. The possible duration of sunshine (PDS) in *Kalanchoe pinnata* habitats
PDS (30.1 - 92.9 %) shows the sample plot date (188 - 580 min. / day) / maximum of survey area (624 min. / day). Na, naturally bare area; Ar, artificially deformed area.

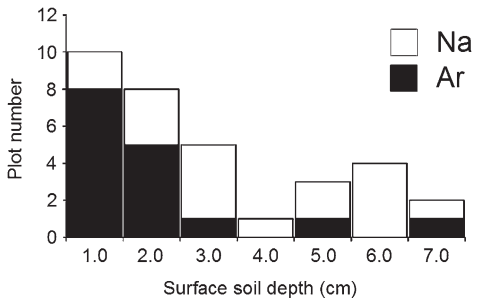

Fig. 4. Surface soil depth in *Kalanchoe pinnata* habitats
Na, naturally bare area; Ar, artificially deformed area.

A distinct difference was observed in mean soil depth values between naturally bare and artificially modified areas (4.7 cm in the naturally bare area vs. 2.4 cm in the artificially modified area), although the ranges of soil depths are completely overlapped between both areas (Fig. 4).

These data suggest that *K. pinnata* grows on habitats that are rich in sunlight but poor in soil. *K. pinnata* could avoid competition with other species by living in such a stressful environment. These results may further imply that *K. pinnata* is not competitive enough to invade habitats of other native species.

References

Environment Agency 1981. The 2nd natural survey on the natural environment (Vegetation), Okinawa actual vegetation maps 1:50000 [Nago]. Environment Agency, Tokyo (in Japanese).

Hayashi, D. 1985. 3B central Ryukyu. In: Kizaki, K. (ed.), Geology of the Ryukyu Archipelago, pp. 93–106. Okinawa Times, Naha (in Japanese).

Iha, Z. 2007. Picture book of Okinawa plants. Ocean Exposition Commemorative Park Management Foundation, Motobu (in Japanese).

Mokusaki, S. 1988. Geology of South Island—Reading the landscape of Okinawa—. Okinawa publishers, Urasoe (in Japanese).

Nakata, E. 1995. The trees and herbs of homevillage—The picture guide book in the Izena Islands—. Izena village board of education, Izena (in Japanese).

Ono, M. and Kobayashi, J. 1985. Endemic species in the Bonin Islands Part 1. In: Ono, M. and Okutomi, K. (eds.), Endemic species and vegetation of the Bonin Islands. Aboc-sha, Kamakura (in Japanese).

Shinzato, T. and Takahara, K. 2002. The picture guide book of plant in the Ie Island. Ie village board of education, Ie (in Japanese).
Takenaka, A. 2009. Hemispherical image analysis program, CanopOn Version 2.03. http://takenaka-akio.org/etc/canopon2/ (accessed November 12, 2012).
Tsukamoto, Y. 1994. The grand dictionary of horticulture Part 2. Shogakukan, Tokyo (in Japanese).

小川滋之：沖縄島における外来種セイロンベンケイの分布と立地環境

外来種のセイロンベンケイは，南西諸島において薬用や園芸用として広く利用されてきたが，野生化した個体の分布や生態については明らかにされていない．本研究では，沖縄島本部半島におけるセイロンベンケイの分布と立地環境を検討した．セイロンベンケイは，中生代と第四紀の石灰岩地域の人工改変地と，わずかに中生代石灰岩地域に位置するカルスト丘の自然裸地に分布した．中生代石灰岩地域は，山地であり森林で覆われることが多く，第四紀石灰岩地域は平坦地であり宅地や畑地などの人工改変地が多い．生育地の分布は，地質ごとの土地利用の違いにより規定されていると考えられた．日射量と土層の厚さに着目して生育地の立地環境をみると，日射量（地点の日照時間／可照日照時間）は，約7割の生育地が70.0%以上であった．土層の厚さでは，自然裸地4.7cm，人工改変地2.4cmであり，土層が薄いほど生育地数は増加した．これらの結果は，セイロンベンケイの生育地が日射量は高いが土層は薄い環境下にみられることを示唆している．セイロンベンケイは他種との環境をめぐる競争を避けているようで，在来種の生育地を侵略する可能性は低いだろう．

（〒271–8510　千葉県松戸市松戸648　千葉大学大学院園芸学研究科）
（Received October 2, 2013; accepted May 20, 2014）